The ILC Engineering Design Phase – Towards the Production of an Engineering Design Report

Marc Ross
August 3, 2007

International Linear Collider Engineering Design Phase - Introduction

In August 2007, the International Linear Collider - Global Design Effort (ILC – GDE) published the ILC Reference Design Report (RDR)[1] which contains a description of the design of the linear collider and a 'value' cost estimate. The RDR was developed over a 2 year period starting in August 2005 with the creation of the GDE at the Second ILC workshop, held at Snowmass, Colorado. The design described in the RDR and its associated estimate allow the GDE to plan and prioritize the next phase of the ILC, the creation of an Engineering Design and the production, by mid 2010, of an Engineering Design Report (EDR).

The EDR will contain, in addition to a more mature design and an updated value estimate, a plan for executing the ILC Project. The purpose of the EDR is to facilitate formal international negotiations at government level on siting, funding, organization and execution of the ILC project with a timescale consistent with the start of construction in 2012. The creation of the ILC Engineering Design will include:

- Basic R&D to demonstrate that all components can be engineered
- R&D into alternative solutions to mitigate remaining risk.
- An overall design to allow machine construction to start within 3 years following its completion,
- selection between high tech options to allow industrialization efforts.
- A comprehensive value-engineering exercise
- A complete value cost estimate for the machine, including a funding profile consistent with the project schedule.
- A project execution plan including a realistic schedule.
- Designs for facilities shared between different "area systems", and for site-specific infrastructure. The designs must include the level of detail needed for regions to estimate the cost to host
- All necessary information must be provided to regions to evaluate project technical and financial risks in support of a bid to host.

With the completion of the EDR, the ILC – GDE leadership will be able to seek approval of the ILC project from governmental agencies.

ILC Reference Design Report – Guidance for the ED Phase

The RDR 'value estimate' methodology is based on experience with large multi-lateral international scientific projects such as the International Tokamak Experimental Reactor (ITER) and experiments at the LHC. The value of a component is defined as the lowest reasonable estimate of the procurement cost of that component. It is effectively the barest cost estimate that would be used by any of the funding agencies. Individual nation's funding agencies can then add to the base value any other items usually included in their own estimating system. Value is a particularly convenient concept for dealing with 'in-kind' contributions, where project participants provide equipment rather than directly providing funds.

The RDR value estimate and the ongoing ILC R & D effort allow a quantitative assessment of the leverage that Engineering Design Phase efforts will have on the ILC Project. A good example is the R & D aimed at justifying the superconducting (SCRF) linac cavity design gradient choice of 31.5 MV/m. This R & D task, which involves a coordinated effort in all regions participating in ILC work, consists of repeated processing and testing of SCRF cavities in order to demonstrate the expected yield and to prove the effectiveness of the chosen 'baseline' cavity preparation procedure. In this example, a 10% reduction in the design gradient would raise the estimated cost of the ILC by about 7%. Each ongoing R & D effort can be ranked in this way resulting a cost and risk mitigation priority assessment.

Towards the Production of an EDR

The GDE is now in the process of restructuring itself and making plans for the engineering design phase, leading to the completion of the ILC Engineering Design Report (EDR) in 2010. The scope of the EDR necessitates a robust management and an appropriate organization with resources sufficient to accomplish its aims. The Engineering Design phase organization must have clear lines of authority and responsibility and must effectively connect tasks with human and financial resources (often from multiple resources across the regions). This must be accomplished while maintaining a strong international collaboration in the absence, at least initially, of centralized funding.

As the RDR neared completion, a Task Force was launched to collect input from the GDE and from contributors to the RDR and to apply Project Management principles in order to propose an appropriate, functional, Work Breakdown Structure to be used during the ED phase. The Task Force report is due in August 2007.

The Engineering Design phase organizational alignment highlights the cost drivers identified in the RDR. Production of high-technology SCRF components and Conventional Facilities and Siting (CFS) together account for 70% of the RDR value

estimate. Accordingly, each has its own branch in the top level EDR Work Breakdown Structure. The third branch is allocated to Accelerator Systems.

A fundamental management principle of the Engineering Design phase will be the containment of the RDR Value estimate. Areas of potential cost-reduction via good engineering practices have been clearly identified in the RDR. While the RDR conceptual design is sound and complete, the overall engineering design remains immature, and the ED phase will bring the application of accelerator systems engineering, industrial development investment and value engineering processes. Value Engineering is an iterative process whereby the ratio: [cost /'worth'], where 'worth' is the lowest possible cost, is minimized. Similar terms are 'trade studies' and 'cost benefit analysis'.

One of the greatest challenges of the ILC is to maintain effective communication paths between co-workers separated by great distances. A great strength of the ILC GDE collaboration is the diverse technical expertise and wide ranging laboratory infrastructure that can be applied to any given problem. This strength is often the result of years of hard work and preparation. In the ED phase, as during the period leading up to the RDR, the community will continue to rely on remote teleconferencing tools, such as the 'Webex' product. In addition, due to the need to iterate through the value engineering process and maintain a strong project management, we will also rely on multi-day, internal, topical face-to-face meetings which have a strong technical focus. These will be summarized three times per year at the Global Design Effort International Collaboration Meetings.

[1] a link to the Reference Design Report can be found: http://www.linearcollider.org/cms/